

HARMONY IN PROGRESS:

**INTEGRATING SCIENCE, TECHNOLOGY,
AND
SOCIAL INNOVATION
FOR SUSTAINABLE DEVELOPMENT GOALS**



**e-Book of Extended Abstract
Negeri Sembilan International (NSIEx) & Research Symposium
2025**

YST003 - OXYPULSE ALERT SYSTEM

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ABSTRACT

The OxyPulse Alert System is a non-invasive IoT device that provides real-time monitoring of blood oxygen levels (SpO_2) and heart rate, particularly for chronic and high-risk patients. Globally, over 262 million people suffer from asthma and 3.5 million die each year from COPD—the 4th leading cause of death. This problem is expected to worsen as the elderly population is projected to grow to 2.1 billion by 2050. In Malaysia, 71% of deaths are from chronic diseases. Among older adults, 51.1% have hypertension, 27.7% have diabetes, and 41.8% have high cholesterol. It addresses this issue using a photoplethysmography sensor with red and infrared LEDs and a photodiode. It calculates SpO_2 from light absorption and tracks heartbeat. A Wemos D1 R1 microcontroller uploads data to Google Sheets, making it easy for doctors and caregivers to access from anywhere. The system uses built-in rules to detect danger signs like $SpO_2 < 90\%$, heart rate > 100 bpm (tachycardia), or < 60 bpm (bradycardia), and immediately sends alerts through a Telegram bot. The design focuses on being affordable, reliable, and easy to set up—using Wi-Fi, low-cost parts, and minimal maintenance. It fits well into home or hospital use, reducing nurses' workload and increasing patient confidence. With Malaysia's digital health market expected to reach USD 834.2 million by 2028, it has strong business potential. It can grow through partnerships with insurers, healthcare providers, and tech firms. By combining real-time monitoring, cloud storage, and instant alerts, it helps detect problems early, reduce costs, and improve the lives of those at risk.

Keywords – Real-time monitoring, SpO_2 and heart rate, photoplethysmography sensor, telegram alert bot, Google Sheets cloud logging

INTRODUCTION

The increasing number of respiratory and cardiovascular diseases worldwide has created a strong need for smarter, proactive healthcare solutions. Chronic illnesses like asthma and COPD place a heavy strain on healthcare systems, especially as people live longer. In Malaysia, the problem is serious—most deaths are now caused by chronic conditions, particularly among the elderly. Although medical technology has advanced, many current methods for tracking oxygen levels and heart rate lack real-time alerts. This can delay urgent care, especially for patients recovering from surgery or managing long-term illnesses at home who need continuous monitoring.

To solve this, the OxyPulse Alert System was developed to connect real-time health data with immediate response. This IoT-based solution uses low-cost, scalable technology to help caregivers and medical staff monitor patients remotely. It improves safety by combining automatic data analysis, cloud access, and instant alerts to address health risks quickly. By allowing early action and reducing hospital readmissions, the system helps

shift healthcare from reactive to preventive—improving care and outcomes for high-risk patients.

OBJECTIVE

The OxyPulse Alert System aims to enhance patient safety by providing a reliable, real-time health monitoring solution. Its specific objectives are to:

- i. **Continuously monitor heart rate and SpO₂** for accurate tracking in chronic and high-risk patients.
- ii. **Detect health abnormalities early**, such as low oxygen levels or irregular heart rates, for timely intervention.
- iii. **Send instant alerts via Telegram** to notify caregivers and medical staff when vital signs exceed safe thresholds.
- iv. **Support remote and home-based monitoring** to reduce hospital visits and improve convenience.
- v. **Ease healthcare professionals' workload** by automating data logging and alerts.

These goals contribute to better health outcomes, lower costs, and more sustainable, patient-centred care.

DESCRIPTION OF THE PROJECT

The OxyPulse Alert System is an IoT-based device that continuously monitors SpO₂ and heart rate, with smart alerts, real-time data logging, and remote cloud access, offering an efficient solution for modern healthcare. Key Features and Functionality:

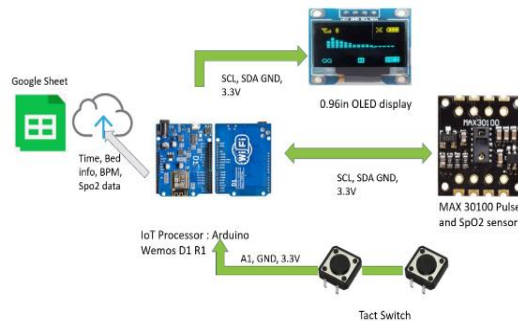


Figure 1: Hardware architecture of the OxyPulse Alert System showing the interaction between sensor, display, tact switch, IoT controller, and Google Sheets.

- **SpO₂ and Heart Rate Sensor**
The system uses a dual-LED (Red and Infrared) photoplethysmography (PPG) sensor to detect oxygenated and deoxygenated hemoglobin. It calculates SpO₂ levels and heartbeat intervals by measuring light absorption through a fingertip.

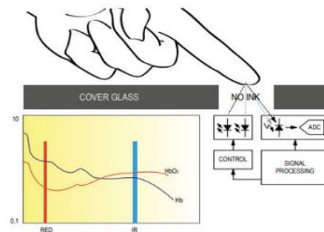


Figure 2: Working principle of the photoplethysmography (PPG) sensor using red and infrared light absorption to differentiate oxygenated (HbO_2) and deoxygenated hemoglobin (Hb).

- Real-Time Monitoring**

Heart rate and SpO_2 data are collected continuously and sent immediately to a connected Google Sheet using the Wemos D1 R1 microcontroller and Wi-Fi connectivity.

- Automated Alert System via Telegram Bot**

When the recorded data falls outside of pre-defined thresholds (e.g., $\text{SpO}_2 < 90\%$, heart rate < 60 bpm or > 100 bpm), a Telegram bot sends instant alerts to medical staff and family members for quick response.

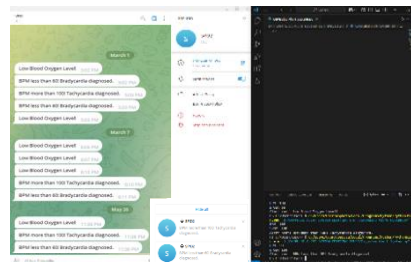
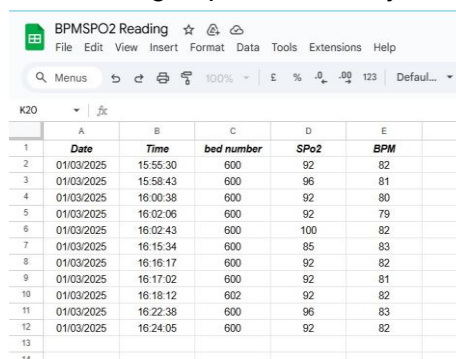


Figure 3: Telegram bot sends automatic alerts when abnormal BPM or SpO_2 values are detected.

- Cloud-Based Data Logging**

All readings are logged automatically to Google Sheets, allowing easy tracking, analysis, and sharing of patient data by healthcare providers.



	A	B	C	D	E	F
	Date	Time	bed number	SPo2	BPM	
1						
2	01/03/2025	15:55:30	600	92	82	
3	01/03/2025	15:58:43	600	96	81	
4	01/03/2025	16:00:38	600	92	80	
5	01/03/2025	16:02:06	600	92	79	
6	01/03/2025	16:02:43	600	100	82	
7	01/03/2025	16:15:34	600	85	83	
8	01/03/2025	16:16:17	600	92	82	
9	01/03/2025	16:17:02	600	92	81	
10	01/03/2025	16:18:12	602	92	82	
11	01/03/2025	16:22:38	600	96	83	
12	01/03/2025	16:24:05	600	92	82	
13						
14						

Figure 4: Real-time logging of SpO_2 and BPM values in Google Sheets with date, time, and bed number.

Usefulness and Practicality:

- For High-Risk Patients: Ideal for the elderly, post-surgery, or chronic illness patients needing continuous monitoring.

- Remote and Home Care: Supports safe self-monitoring at home with remote access for doctors.
- Reduced Medical Staff Workload: Automates data recording and alerts, minimizing errors and easing nurses' duties.
- Affordable and Scalable: Low-cost and easy to install, suitable for both small clinics and large facilities.

It offers a scalable, efficient way to improve care, safety, and emergency response.



Figure 5: Completed OxyPulse prototype displaying live readings on OLED screen.

NOVELTY

The novelty of the OxyPulse Alert System lies in its integration of real-time monitoring with an automatic alert mechanism, enabling immediate action when abnormal oxygen levels or heart rates are detected. Unlike traditional methods that often detect issues only after a delay, this system continuously tracks vital signs and promptly notifies patients, caregivers, and medical personnel via visual and audio alerts. Its uniqueness also stems from its user-friendly design and potential for integration with mobile notifications, which enhances patient safety, particularly for individuals with chronic illnesses or at high risk. This proactive approach in health monitoring makes the system an innovative step forward in digital healthcare technology.

CONCLUSION

The OxyPulse Alert System offers an effective and innovative solution for continuous monitoring of blood oxygen levels and heart rate. By addressing the limitations of traditional monitoring methods, it enhances early detection of irregularities and ensures swift responses through its built-in alert system. This proactive approach can greatly benefit patients with chronic conditions or those requiring constant supervision. With its real-time functionality and user-friendly features, the system has the potential to improve healthcare safety, reduce emergency response time, and provide peace of mind to both patients and caregivers.